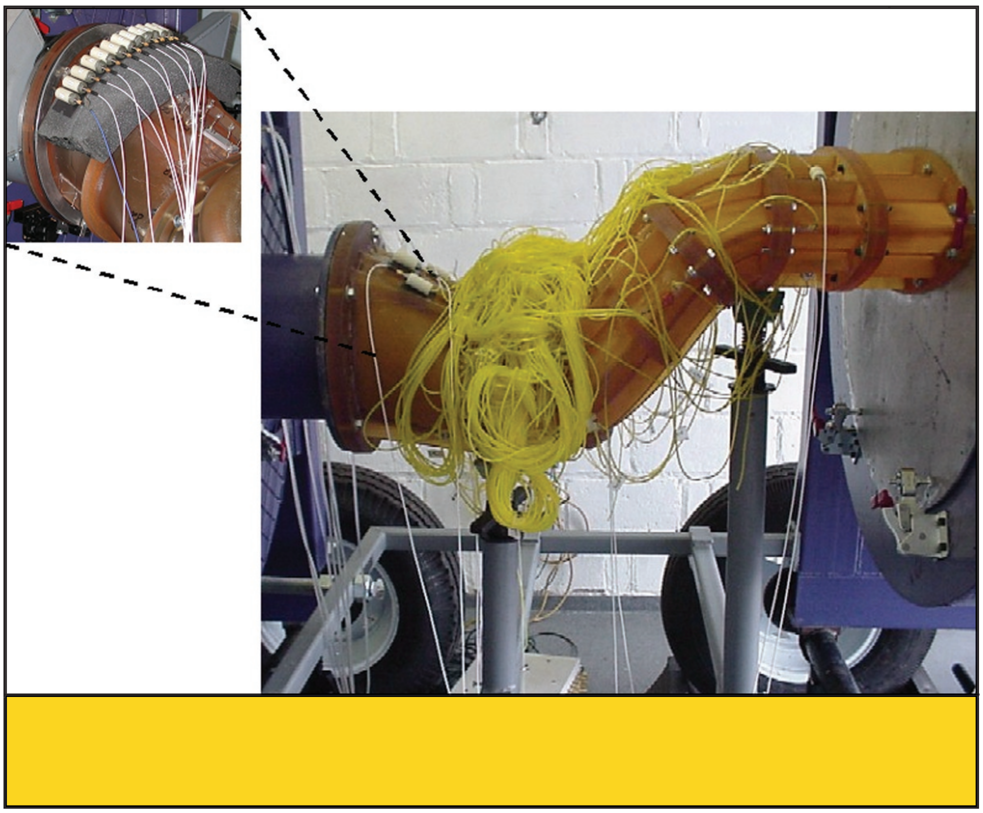
Air Force Research Laboratory | AFRL

Science and Technology for Tomorrow's Air and Space Force

Air Force SBIR

Success Story

AIR VEHICLES DIRECTORATE DEMONSTRATES A COMPACT, HIGHLY OFFSET SERPENTINE INLET DUCT



Realistic flight conditions, such as aircraft maneuvers, constantly change the degree to which serpentine inlets distort the airflow, causing fluctuations in aircraft performance. A feedback control system is therefore necessary to deliver appropriate pressure distortion control during any given flight condition to maintain aircraft performance. Using this technology will allow for smaller, lighter, more cost-efficient unmanned air vehicles (UAVs) with consistent performance levels as the controller adjusts and corrects for air flow distortions less than a second after receiving feedback.

Air Force Research Laboratory
Wright-Patterson AFB OH

Accomplishment

The Air Vehicles Directorate, in cooperation with Techsburg, Inc., demonstrated, for the first time anywhere, closed loop control of pressure distortion in a compact, highly offset serpentine inlet duct. The directorate and Techsburg, Inc. performed the demonstration under the US Air Force Small Business Innovation Research program, using flow control techniques developed with Lockheed Martin Aeronautics Company and the National Aeronautics and Space Administration's Glenn Research Center.

Microphones measuring the amplitudes of the pressure fluctuations at the exit plane of the inlet served as the non-intrusive feedback sensors for this study. Directorate engineers hypothesized that microphones near the distorted flow would record higher amplitudes of pressure fluctuations compared to microphones near the undistorted flow.

The engineers discovered that the difference between the microphone readings in these two flow regimes was strongly correlated to the distortion level and could therefore serve as the feedback signal to a controller. This approach led to a successful demonstration of an active flow control system that maintained a specified distortion level during a simulated transient flight condition.

Background

The Air Force is designing aircraft, such as UAVs, smaller and more volume-constrained in order to meet stringent performance and cost requirements. Because the propulsion system often drives the size of these aircraft, UAVs will require highly integrated propulsion systems that complement emerging engine technologies to achieve vehicle performance and cost goals.

Researchers require next-generation inlet systems to be compact and ultra-efficient for UAVs. Additionally, these inlet systems must be winding and serpentine (wavy, resembling a serpent) to be less observable to enemy radar.

Traditionally, as inlets become shorter and more serpentine, aerodynamic performance suffers. To overcome these problems in the past, engineers used complex, costly, and heavy techniques such as boundary layer suction.

Recent studies in active flow control demonstrate that using small inputs to create large changes in flow structure can control flows in compact serpentine inlets. Active flow control is an enabling technology for highly compact inlet systems that allows a reduction in system weight and cost while maintaining the high performance of traditional inlets.

Air Vehicles
Emerging Technologies

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (02-VA-04)